Technical Note N-968

DECONTAMINATION UNIT FOR BIOLOGICAL AND CHEMICAL WARFARE

BY

Allan S. Hodgson, Ph.D. and R. S. Chapler

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NAVAL CIVIL ENGINEERING LABORATORY
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DECONTAMINATION UNIT FOR BIOLOGICAL AND CHEMICAL WARFARE

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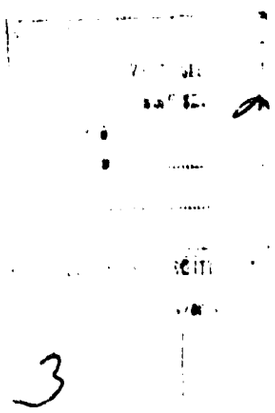
ABSTRACT

A study has been made of a new system developed to update and improve biological and chemical warfare decontamination equipment. An apparatus was required to meter, mix and disperse five specified solutions in water from separate storage tanks with the relative flow rates of the fluids to be maintained with considerable accuracy. The preliminary development of a unit is described. Fabrication of the unit was not pursued because its weight and cost were large enough to suggest that the five solution decontamination mixture must be further evaluated on a laboratory scale to completely justify the necessity of this equipment.



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INTRODUCTION

Existing decontamination units* consisting of a mixing and storage tank with associated pump and engine have several operational disadvantages. The decontaminating solution, in slurry form, requires a considerable mixing time, tends to clog pumps, hoses and dispensing nozzles and the unit needs extensive cleaning after each period of operation.

To overcome these problems a new nonslurry decontamination mixture was developed at the Naval Research Laboratory. This mixture consists of five different additives which must be introduced into a water stream before dispersal. Additional advantages of the new mixture are a greater wetting ability to assist decontamination, a less corrosive mixture and improved operation at low temperatures. Due to the incompatibility of the additive solutions, it was required that each have a separate storage tank and that mixing of predetermined amounted be achieved with considerable accuracy just prior to discharge.

The objective was to develop an experimental unit for testing the metering and mixing devices, determining the chemical concentrations required in field use and feasibility of this type of unit.

DECONTAMINATION UNIT DEVELOPMENT

The equipment was to be designed to mix solutions for controlling pH, detergency, freezing point and corrosiveness of the decontaminating solution. The mixture to be dispersed from the equipment was anticipated to consist of the following typical compositions and proportions.

Water	10 gpm at 50 psi
Calcium hypochlorite solution, 5%	1 gpm
Detergent solution, 5%	1 gpm
Sodium dihydrogen phosphate solution (NaH_2PO_4), 10%	1 gpm
Deicing liquid	5 gpm
Organic acid	1 gpm

Although the unit was to be experimental in nature, it was desirable that the design should be as close as possible to the field

*U. S. Marine Corps Technical Manual, TM-04195A-12, Decontaminating Apparatus M12 Type II, Oct. 1965, FSN 4230-902-3224.

unit. The experimental unit would be used in a series of different field tests and depending on the results, minor design changes might be necessary for the production unit. The experimental unit was to have a considerable range of absolute and relative flow rates and the initial study produced four design concepts which were examined. The four concepts differed in the method of metering the solutions as follows:

1. Pneumatic pumping and manual control valves
2. Eductor pumping and manual control valves
3. Centrifugal pumping and manual control valves
4. Metered pumping

On further investigation, it was found that eductors were unsuitable due to their low efficiency and this concept was discarded. The concepts using compressed air or centrifugal pumps with manual control valves and flow meters were not considered suitable for the experimental unit due to the problem of accurately controlling flow rate with this type of system and the necessity of a more complex arrangement. The components of the three concepts considered practical have comparable weight and volume requirements and since metering pumps met the demand for accurate, variable solution flow rates, this concept was used for investigation of the prototype unit. The concept is illustrated schematically in Figure 1.

The apparatus was required to operate continuously for ten minutes with the capability for separate storage of the additive solutions for extended periods of time. The water supply was assumed available from external sources. All the pumps were to be driven by a single gasoline engine. The equipment had to be capable of starting and operating at ambient temperatures from 20°F to 130°F with discharge of the decontamination agent through a retractable hose and an adjustable spray nozzle. The whole unit was to be as compact as possible, assembled as a single unit and suitable for transportation by truck or trailer.

PROTOTYPE DECONTAMINATION UNIT DESIGN

A contract was awarded to The Ben Holt Company of Pasadena, California to complete a detailed design of the unit and produce drawings and specifications together with a detailed cost estimate for the construction. Design specifications and operation and maintenance manuals were received with a breakdown of the costs of individual items required for fabrication.

The unit is illustrated in Figures 2 to 8 and specific items are listed below.

1. Pumps. The water supply pump is of the vane type designed to deliver 10 gpm at 70 psi with adjustment of the flow rate accomplished by throttling of the discharge. The pump may be operated using water from streams, ponds, fire hydrants or other sources; a retractable suction hose is provided. The deicing fluid pump is of a similar type with means of accurately metering the discharge rates and provisions for water flushing and draining.

The remaining pumps (four) for the decontamination solutions are piston type metering pumps capable of fluid delivery rates from zero to the full specified flow. A scale is provided for accurate, reproducible settings of pump output. The pumps are of corrosion resistant materials and means of flushing and draining are provided.

The range of flow rates for the specified solutions are:

Calcium hypochlorite solution	0-2 gpm
Detergent solution	0-2 gpm
Sodium dihydrogen phosphate solution	0-2 gpm
Organic acid	0-2 gpm
Deicing fluid (ethylene glycol)	2-8 gpm

Since the deicing fluid required a rather high pump capacity and less accurate metering, it was pumped by an adjustable flow vane-type pump in conjunction with a rotameter. Flow rate accuracy for the other four solutions using metering pumps was $\pm$ 1 percent.

2. Storage tanks. Fiberglas reinforced polyester resin or polyethylene tanks are suitable for storage of the solutions and are of such a size as to provide ten minutes operation time at the specified maximum flow rates.

3. Drive. Power is provided by a gasoline engine with the required accessories and auxiliaries for efficient and dependable operation. The pumps are on a common base and driven from a single shaft through a clutch and speed reducer. The metering pumps or the deicing pump may be taken out of service by setting the appropriate pump control to zero flow.

4. Miscellaneous. Steel pipe and cast iron fittings are used in water and deicing service with polyvinyl chloride pipe, valves and fittings for the decontaminatng chemicals. Mixing of the solutions is achieved by a polyvinyl chloride eductor type device designed for minimum pressure drop. Flow meters are provided on water and deicing fluid lines for the experimental unit. The hose is of Hypalon core

with neoprene cover and nylon braid, and is supplied with an adjustable brass spray nozzle at the downstream end.

The total cost of the complete unit is shown in Table 1. The amount is a conservative estimate for a single experimental unit, while considerable decrease would be likely if fabrication was undertaken for a production unit.

Table 1. Decontamination unit cost breakdown.*

Material	$10,000
Fabrication	4,840
Shop drawings	1,200
Inspection and testing	4,210
TOTAL	$20,250

The weight of the pumps, engine and tanks (when full) is considerable and thus the unit required a substantial base and framework. The dimensions and weight of the unit are shown in Table 2.

Table 2. Decontamination unit weight and dimensions.*

Length	10 ft
Width	5 ft 6 in
Height	6 ft
Weight (tanks empty)	3,425 lbs
Weight (tanks full)	4,610 lbs

*Figure based on quotation by The Ben Holt Company.

CONCLUSIONS AND RECOMMENDATIONS

A relatively heavy and expensive piece of field equipment is required to comply with the specifications for dispersal of the five solution decontamination mixture. The mixture is still under development and further tests by the Naval Research Laboratory may show that one or more of the solutions can be eliminated or that stronger concentrations are suitable, thereby reducing the tank storage requirements.

Consequently, fabrication of the unit is not recommended until further laboratory scale evaluations of the mixture can fully justify the development.

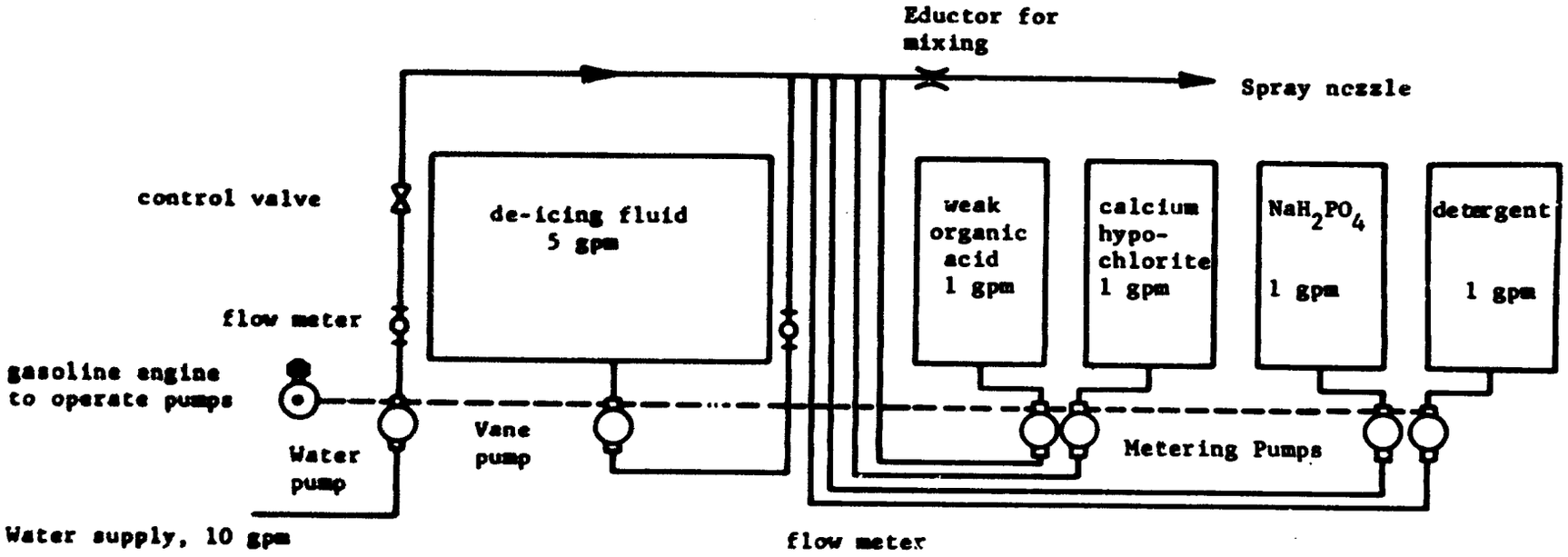


Figure 1. Decontamination unit using metering pumps.

J-1
MIXING EDUCTOR

K-5
RETRACTABLE HOSE REEL ASSEMBLY

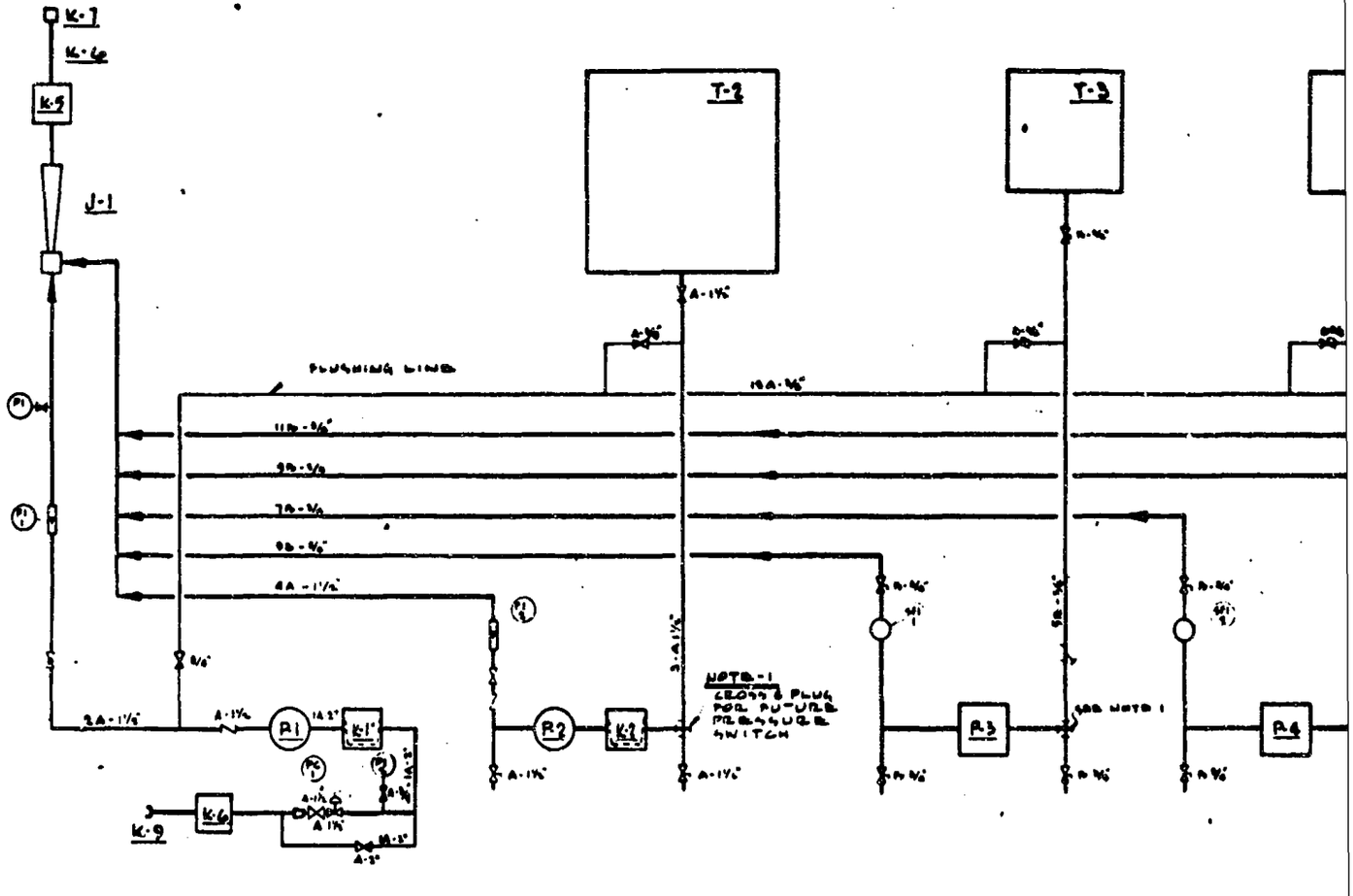
K-6a
DISCHARGE CHEMICAL HOSE

T-2
DEICING FLUID CAP. 80 GALS

T-3
WEAK ORGANIC ACID CAP. 80 GALS

5% HYPOCH CAP

K-7
DISCHARGE SPRAY NOZZLE



K-9
FIRE HYDRANT FITTING

P-1
WATER PUMP
10 GPM
DISCH PRESS = 70 PSI
VIKING MODEL HL 124 BRONZE FITTED 600 RPM

P-2
DEICING FLUID PUMP
8 GPM MAX.
DISCH. PRESS = 70 PSI
BEAM SEE VARI-FLO VELO -PD 600 RPM

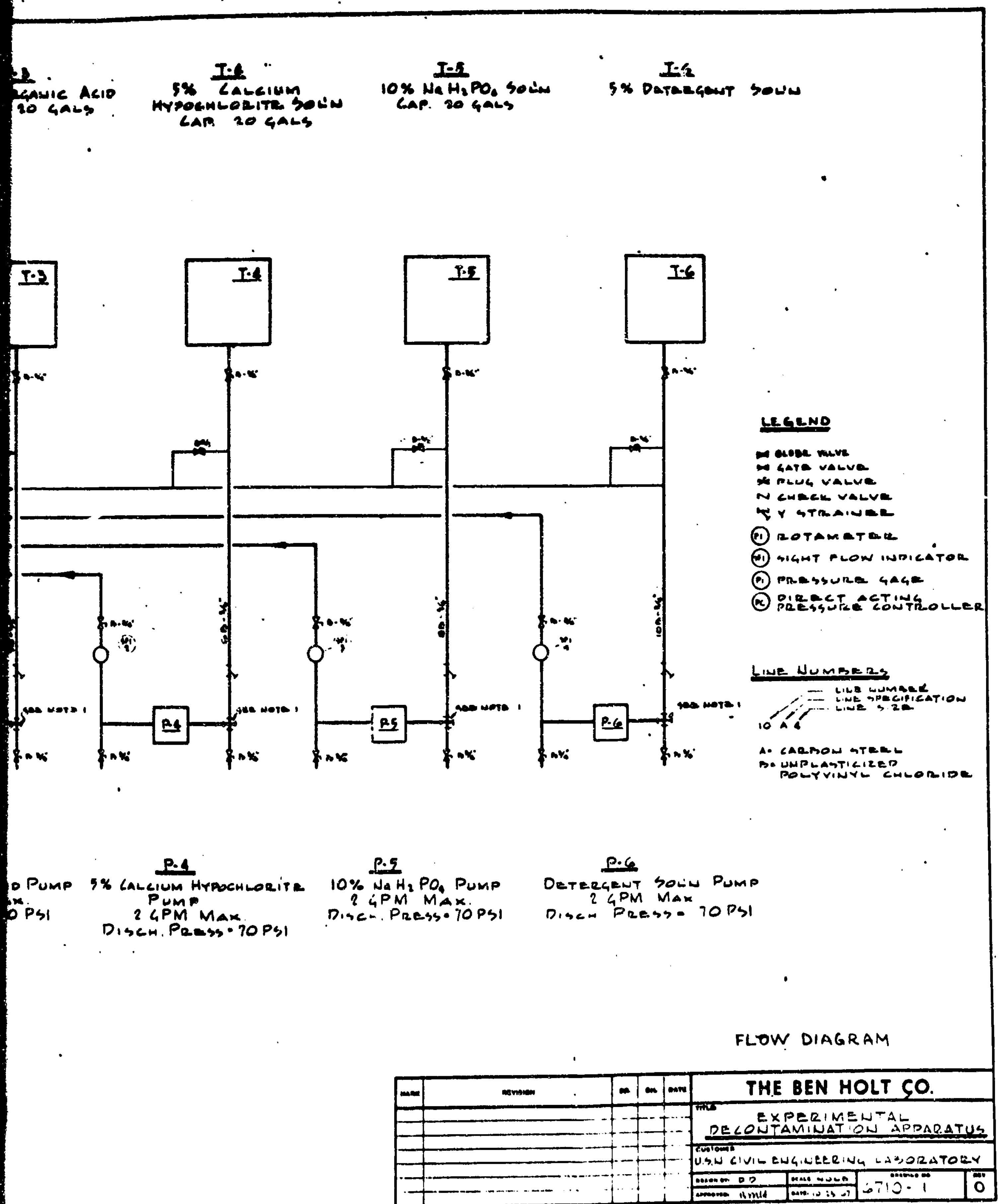
P-3
WEAK ORGANIC ACID PUMP
? GPM MAX.
DISCH. PRESS 70 PSI

P-4
5% CALCIUM HYP PUMP
? GPM M
DISCH. PRES

K-6
RETRACTABLE HOSE ASSEMBLY

K-1
BASKET STRAINER

K-2
BASKET STRAINER


T-4
5% Calcium Hypochlorite Soln
Cap. 20 Gals
T-5
10% NaH_2PO_4 Soln
Cap. 20 Gals
T-6
5% Detergent Soln
T-3
T-4
T-5
T-6
LEGEND
Globe Valve
Gate Valve
Plug Valve
Check Valve
Y Strainer
(FI) Rotameter
(SFI) Sight Flow Indicator
(PI) Pressure Gage
(PC) Direct Acting Pressure Controller
Line Numbers
Line Number
Line Specification
Line Size
10 A 4
A - Carbon Steel
B - Unplasticized Polyvinyl Chloride
See Note 1
P-4
P-5
P-6
P-4
5% Calcium Hypochlorite Pump
2 GPM Max.
Disch. Press = 70 PSI
P-5
10% NaH_2PO_4 Pump
2 GPM Max.
Disch. Press = 70 PSI
P-6
Detergent Soln Pump
2 GPM Max
Disch Press = 70 PSI
FLOW DIAGRAM
THE BEN HOLT CO.
Experimental Decontamination Apparatus
U.S.N. Civil Engineering Laboratory
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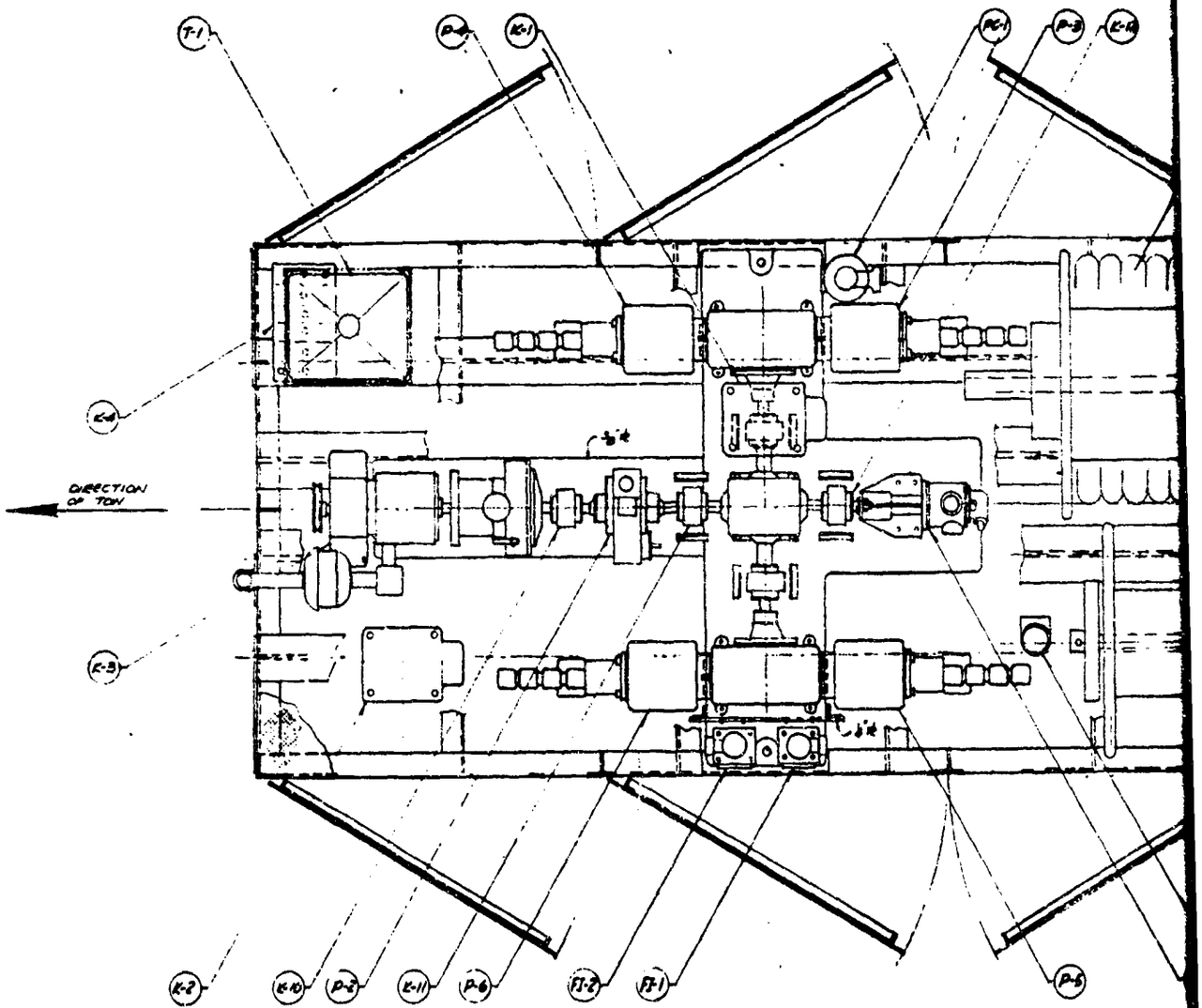
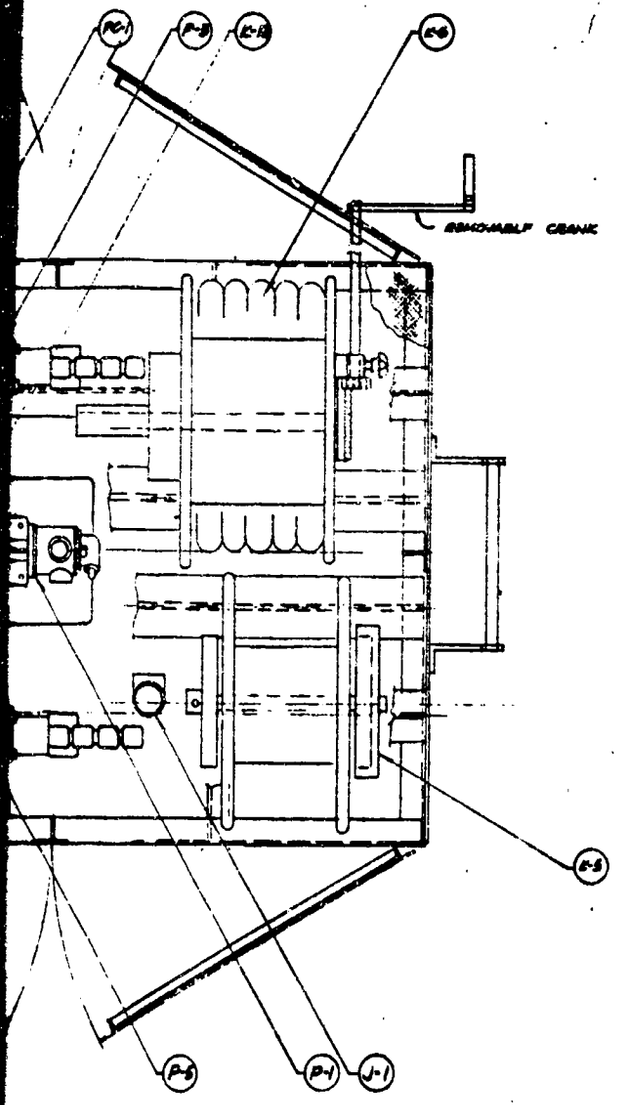


NOTES

1) FABRICATOR SHALL SUIT
ALL THE BIDING IN-LINE
ORDER NOT TO TRANSFER
VIBRATION TO MECHANICA

2) ALL STRUCTURAL STEEL
SHOP COAT OF ZINC CHROMAT

3) ALL CONNECTIONS OF STE
TO BE CONTINUOUS FILLET



ITEM	DESCRIPTION	MATERIAL	WT lb
T - 6	6 % DETERGENT SOLUTION TANK - 80 GAL.	REINFORCED PLASTIC	86
T - 5	10 % ADAC PQ PHOSPHATE SOLUTION TANK - 80 GAL.	REINFORCED PLASTIC	86
T - 4	5 % CALCIUM HYPOCHLORITE SOLUTION TANK - 80 GAL.	REINFORCED PLASTIC	86
T - 3	WEAK ORGANIC ACID TANK - 80 GAL.	REINFORCED PLASTIC	86
T - 2	DEICING FLUID TANK - 80 GAL.	REINFORCED PLASTIC	66
T - 1	FUEL TANK	METAL	15
P - 6	DETERGENT SOLUTION PISTON PUMP		
P - 5	PHOSPHATE SOLUTION PISTON PUMP		
P - 4	CALCIUM HYPOCHLORITE SOLUTION PISTON PUMP		>1200
P - 3	ORGANIC ACID PISTON PUMP		
P - 2	ROTARY DEICING FLUID PUMP	(BLACKMER)	60
P - 1	ROTARY WATER PUMP	(WEMCO)	40
PC - 1	PRESSURE REGULATOR		10
PI - 2	PRESSURE GAGE - DOWNSTREAM WATER PRESSURE REGULATOR		2
PI - 1	PRESSURE GAGE - UPSTREAM MIXER		2
SFI - 4	SIGHT FLOW INDICATOR - DETERGENT		2
SFI - 3	SIGHT FLOW INDICATOR - PHOSPHATE		2
SFI - 2	SIGHT FLOW INDICATOR - CALCIUM HYPOCHLORITE		2
SFI - 1	SIGHT FLOW INDICATOR - ORGANIC ACID		2
FI - 2	DEICING FLUID ROTAMETER - 1"		5
FI - 1	WATER ROTAMETER - 1"		5
J - 1	MIXING EDUCTOR		2
E -12	SHAFT COUPLING - SPEED REDUCER TO VIKING PUMP		5
E -11	SHAFT COUPLING, BLACKMER PUMP TO SPEED REDUCER		5
E -10	SHAFT COUPLING, ENGINE TO BLACKMER PUMP		5
E - 9	DISCHARGE CHEMICAL HOSE		
E - 8	HOSE CONNECTION - SUCTION		5
E - 7	ADJUSTABLE SPRAY NOZZLE		5
E - 6	RETRACTABLE HOSE ASSEMBLY - SUCTION W/ HOSE		200
E - 5	RETRACTABLE HOSE ASSEMBLY - DISCHARGE W/HOSE		150
E - 4	12-VOLT BATTERY		87
E - 3	GAS. ENGINE DRIVE & SPEED REDUCER		170
E - 2	BASKET STRAINER - DEICING FLUID		40
E - 1	BASKET STRAINER - WATER		40

NOTES

1) FABRICATOR SHALL SUITABLY SUPPORT ALL THE PIPING IN-LINE EQUIPMENT IN ORDER NOT TO TRANSFER LOADS AND VIBRATION TO MECHANICAL EQUIPMENT.
2) ALL STRUCTURAL STEEL TO HAVE ONE SHOP COAT OF ZINC CHROMATE PRIMER.
3) ALL CONNECTIONS OF STRUCTURAL STEEL TO BE CONTINUOUS FILLET WELDED.

MARK	REVISION	BY	CH	DATE

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TITLE: GENERAL ARRANGEMENT — PLAN
EXPERIMENTAL DECONTAMINATION APPARATUS

CUSTOMER: U.S. NAVY
CIVIL ENGINEERING LABORATORY

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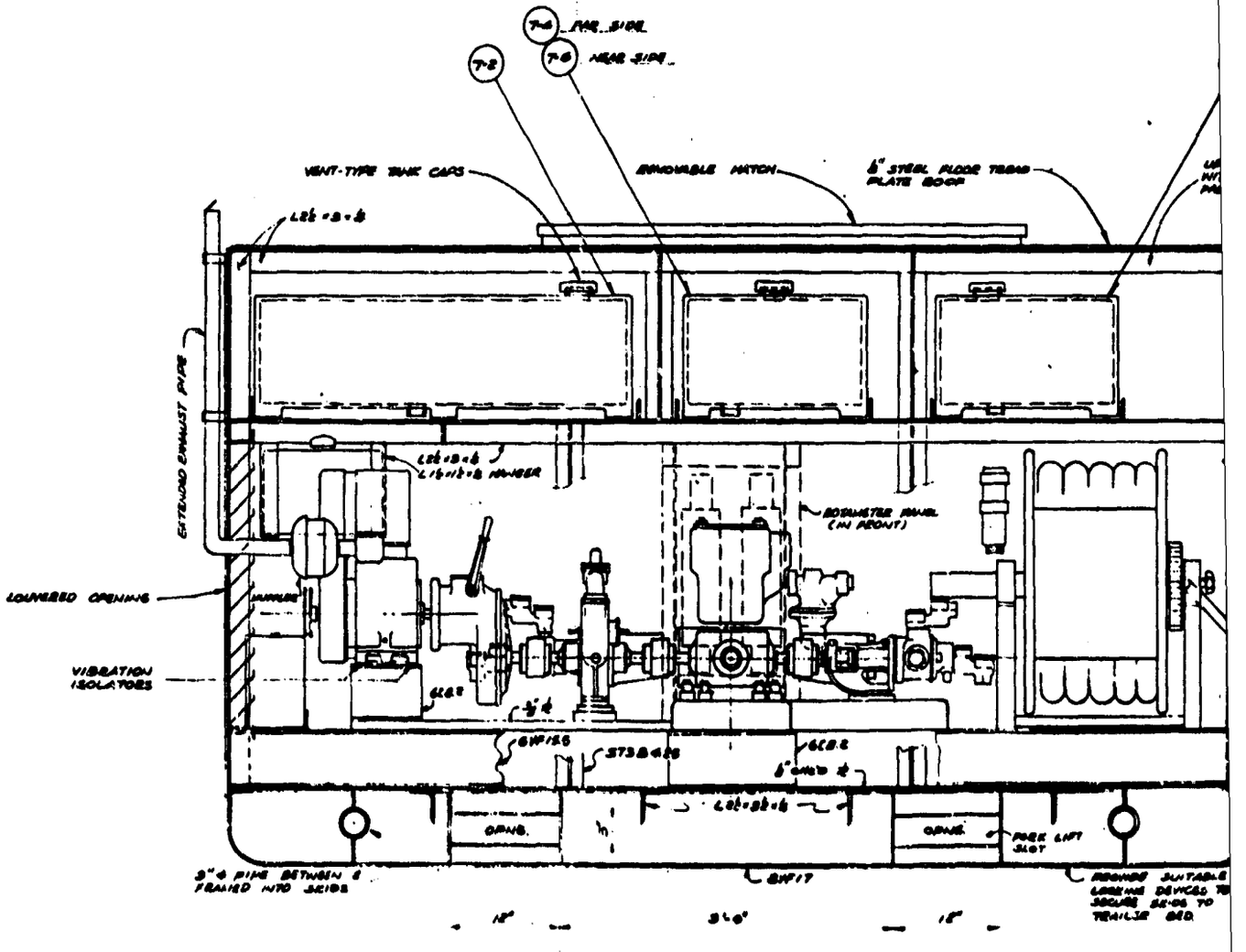
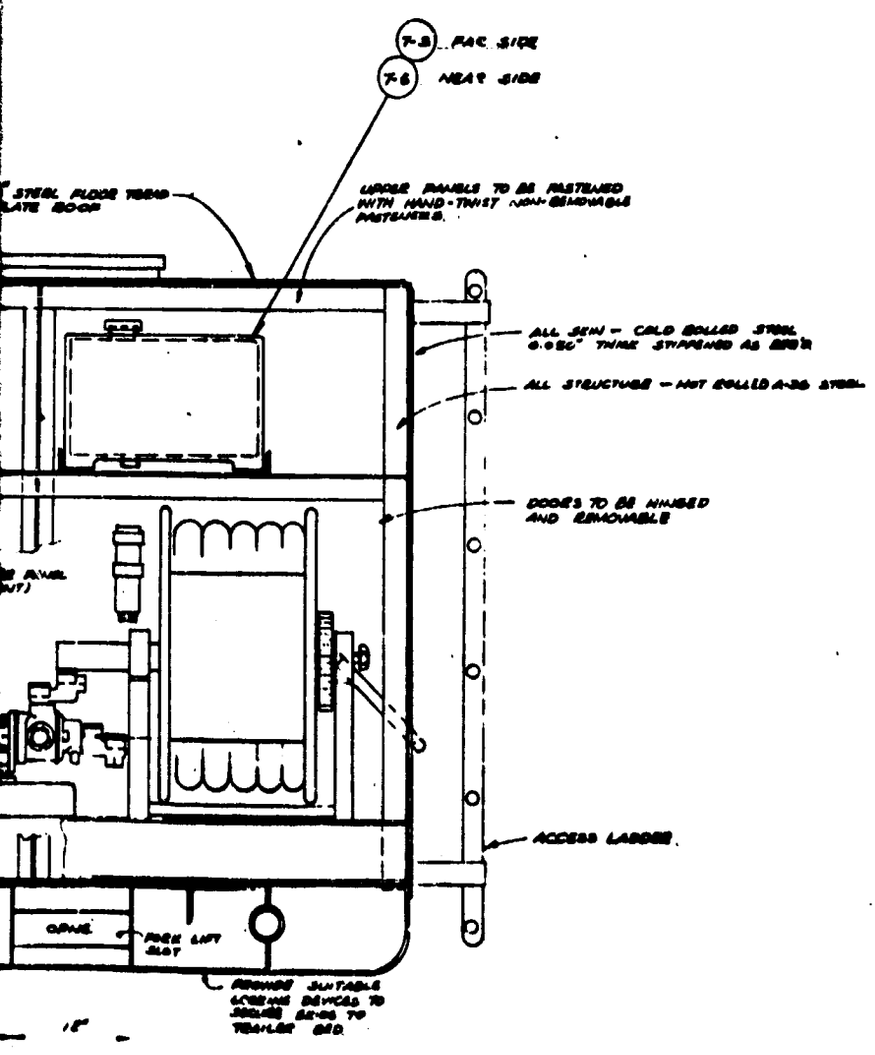

7-4 FAR SIDE
7-2
7-6 NEAR SIDE
VENT-TYPE TANK CAPS
REMOVABLE HATCH
EXTENDED EXHAUST PIPE
LOUVERED OPENING
VIBRATION ISOLATORS
BOOMSTER RAIL (IN FRONT)
OPNG.
OPNG.
FORK LIFT SLOT
3"ø PIPE BETWEEN 2 FRAMED INTO SKIDS

A



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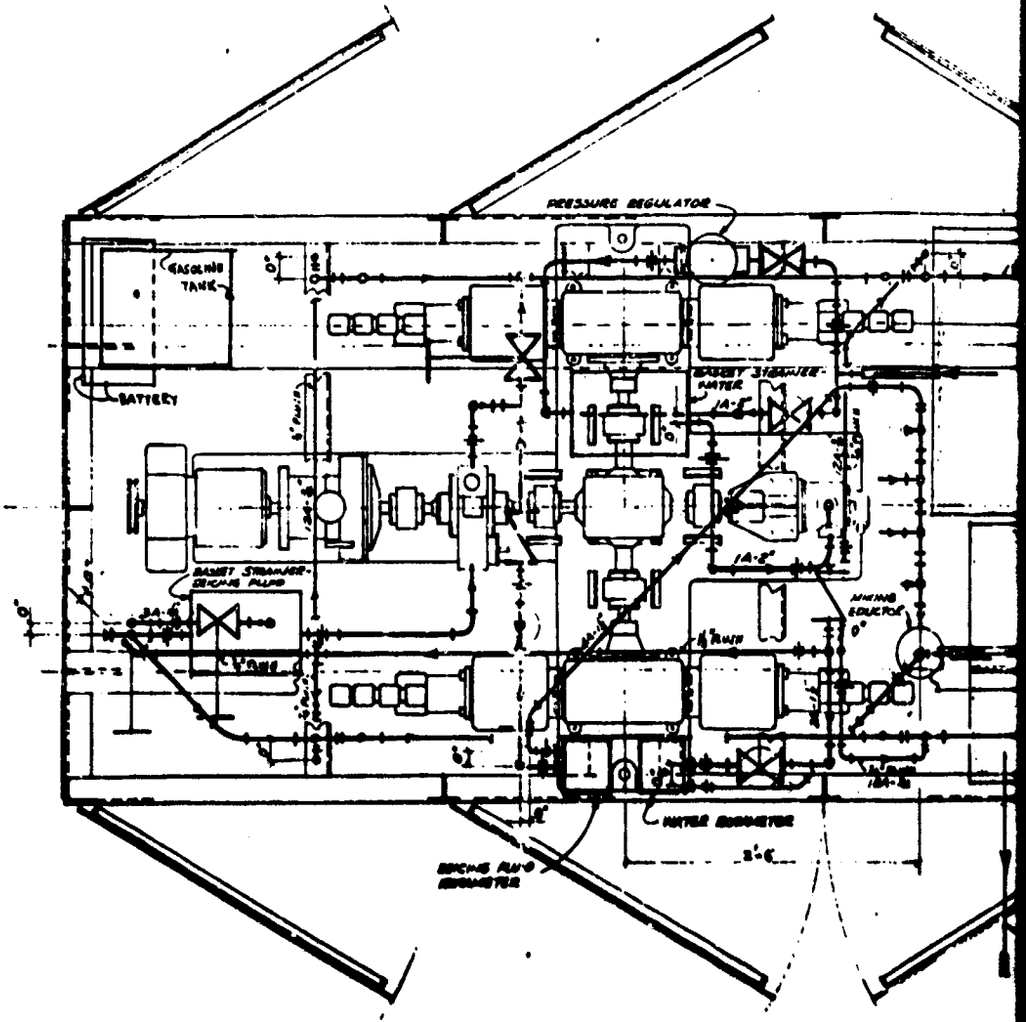
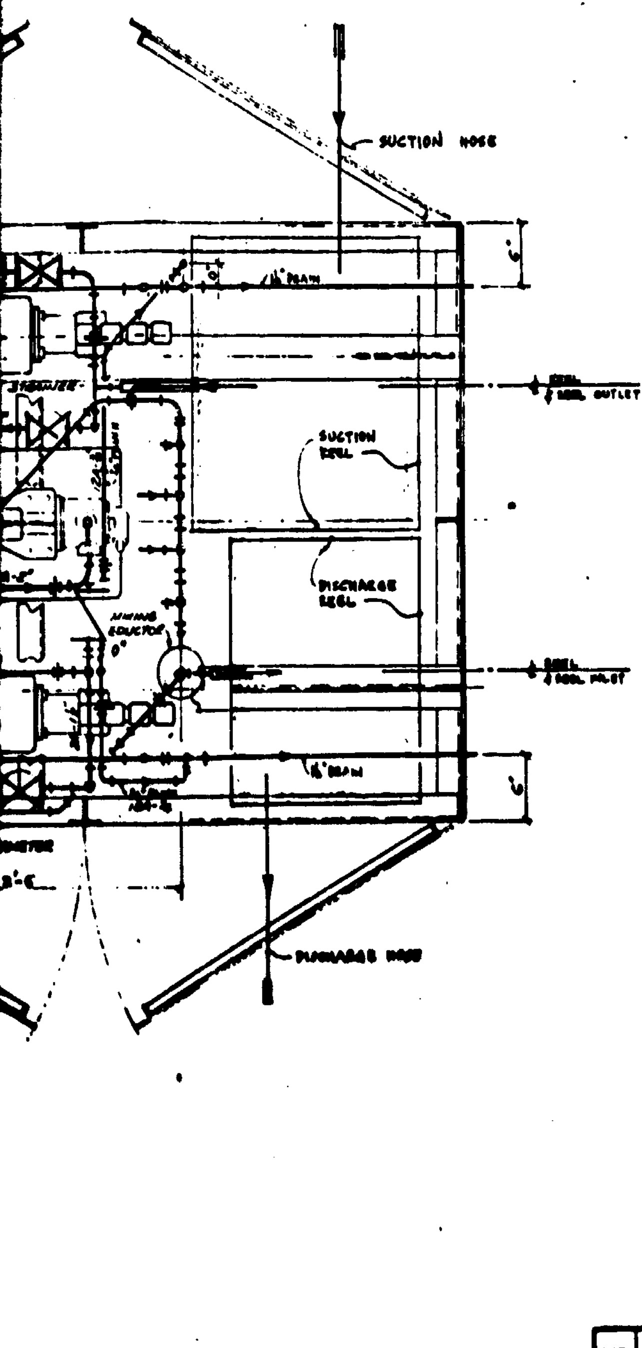
					GENERAL ARRANGEMENT - ELEVATION EXPERIMENTAL DECONTAMINATION APPARATUS
					U.S. NAVY CIVIL ENGINEERING LABORATORY
					6710-9

PIPING LEGEND

- GATE VALVE
- PLUG VALVE
- CHECK VALVE
- Y - STRAINER
- UNION (SCREWED)
- BUSHING
- PLUG





ITEM	DESCRIPTION	MATERIAL	WT #
T - 6	5 % DETERGENT SOLUTION TANK - 80 GAL.	REINFORCED PLASTIC	26
T - 5	10 % NaH₂PO₄ PHOSPHATE SOLUTION TANK - 80 GAL	REINFORCED PLASTIC	26
T - 4	5 % CALCIUM HYPOCHLORITE SOLUTION TANK - 80 GAL	REINFORCED PLASTIC	26
T - 3	WEAK ORGANIC ACID TANK - 10 GAL	REINFORCED PLASTIC	26
T - 2	DEICING FLUID TANK - 80 GAL	REINFORCED PLASTIC	66
T - 1	FUEL TANK	METAL	
P - 6	DETERGENT SOLUTION PISTON PUMP		1200
P - 5	PHOSPHATE SOLUTION PISTON PUMP		
P - 4	CALCIUM HYPOCHLORITE SOLUTION PISTON PUMP		
P - 3	ORGANIC ACID PISTON PUMP		
P - 2	ROTARY DEICING FLUID PUMP	(BLACKMER)	68
P - 1	ROTARY WATER PUMP	(VIKING)	60
PC - 1	PRESSURE REGULATOR		
PI - 2	PRESSURE GAGE - DOWNSTREAM WATER PRESSURE REGULATOR		
PI - 1	PRESSURE GAGE - UPSTREAM MIXER		
SFI - 4	SIGHT FLOW INDICATOR - DETERGENT		2
SFI - 3	SIGHT FLOW INDICATOR - PHOSPHATE		2
SFI - 2	SIGHT FLOW INDICATOR - CALCIUM HYPOCHLORITE		2
SFI - 1	SIGHT FLOW INDICATOR - ORGANIC ACID		2
FI - 2	DEICING FLUID ROTAMETER		
FI - 1	WATER ROTAMETER		
J - 1	MIXING EDUCTOR		2
E - 12	SHAFT COUPLING, SPEED REDUCER TO VIKING PUMP		2
E - 11	SHAFT COUPLING, BLACKMER PUMP TO SPEED REDUCER		2
E - 10	SHAFT COUPLING, ENGINE TO BLACKMER PUMP		4
E - 9	DISCHARGE CHEMICAL HOSE		
E - 8	HOSE CONNECTION - SUCTION		
E - 7	ADJUSTABLE SPRAY NOZZLE		
E - 6	RETRACTABLE HOSE ASSEMBLY - SUCTION W/ HOSE		
E - 5	RETRACTABLE HOSE ASSEMBLY - DISCHARGE		
E - 4	12-VOLT BATTERY		27
E - 3	GAS ENGINE DRIVE & SPEED REDUCER		170
E - 2	BASKET STRAINER - DEICING FLUID		40
E - 1	BASKET STRAINER - WATER		40

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PIPING PLAN - WATER AND DEICING FLUID EXPERIMENTAL DECONTAMINATION APPARATUS

U. S NAVY
CIVIL ENGINEERING LABORATORY

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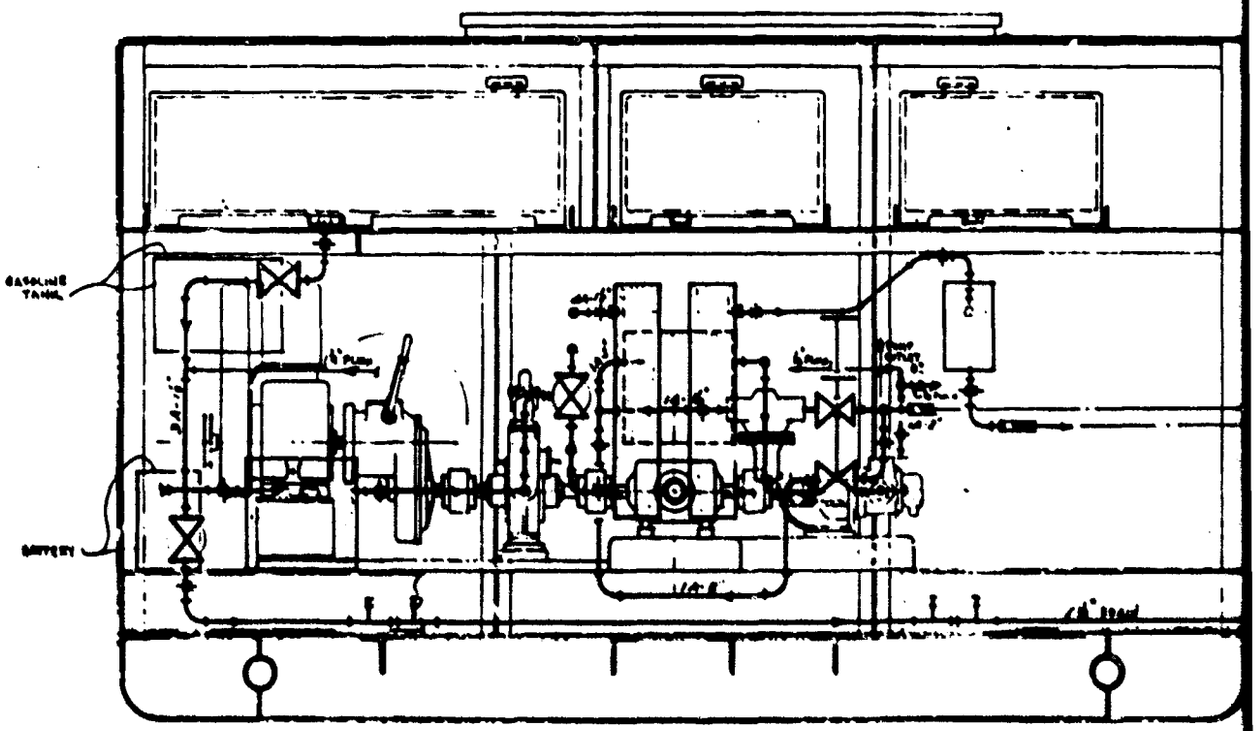
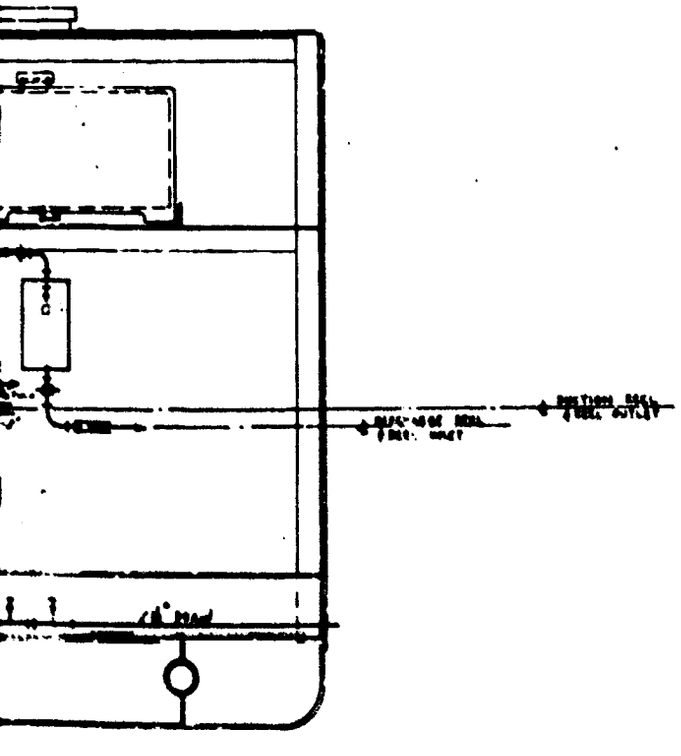
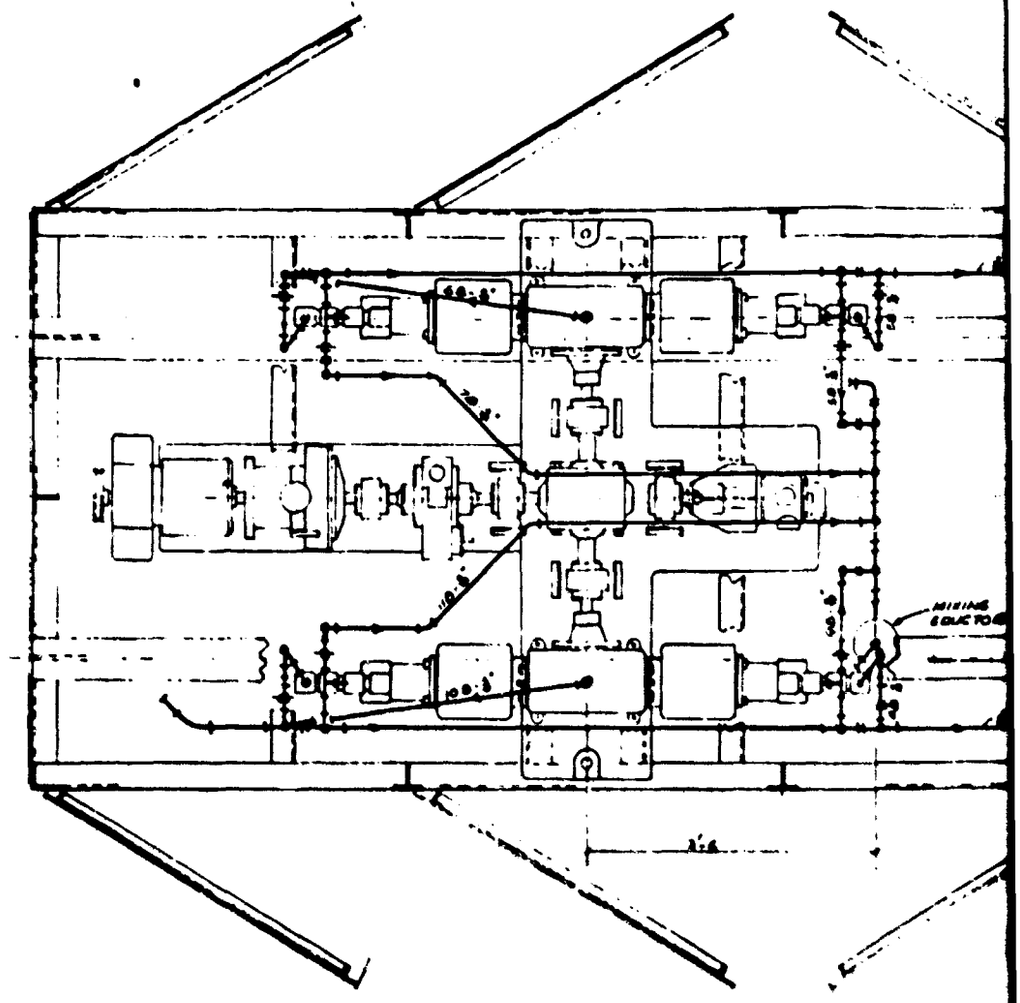
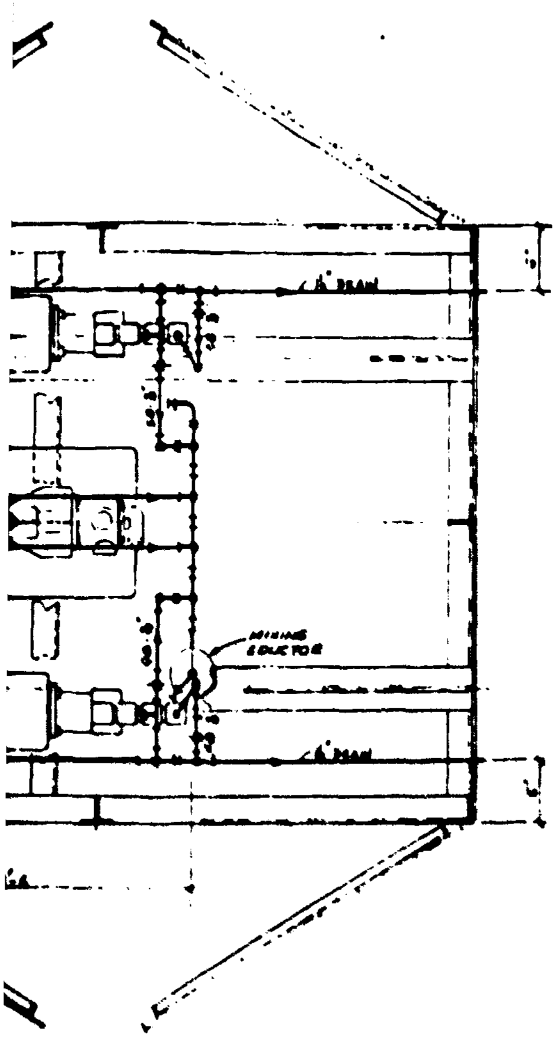

GASOLINE TANK
SAFETY



				THE BEN HOLT CO.
				PIPING ELEVATION - WATER & DECING FLUID EXPERIMENTAL DECONTAMINATION APPARATUS
				U. S. NAVY CIVIL ENGINEERING LABORATORY
				DWG. NO. 5

13





ITEM	DESCRIPTION	MATERIAL	WT
T - 6	5 [illegible] DETERGENT SOLUTION TANK - 80 GAL	REINFORCED PLASTIC	[illegible]
T - 5	10 [illegible] PHOSPHATE SOLUTION TANK - 80 GAL	REINFORCED PLASTIC	76
T - 4	5 [illegible] CALCIUM HYPOCHLORITE SOLUTION TANK - 80 GAL	REINFORCED PLASTIC	[illegible]
T - 3	[illegible] ORGANIC ACID TANK - 30 GAL.	REINFORCED PLASTIC	[illegible]
T - 2	DEICING FLUID TANK - 80 GAL	REINFORCED PLASTIC	66
T - 1	FUEL TANK	METAL	
P - 6	DETERGENT SOLUTION PISTON PUMP		
P - 5	PHOSPHATE SOLUTION PISTON PUMP		)1200
P - 4	CALCIUM HYPOCHLORITE SOLUTION PISTON PUMP		
P - 3	ORGANIC ACID PISTON PUMP		
P - 2	ROTARY DEICING FLUID PUMP	(BLACKMER)	60
P - 1	ROTARY WATER PUMP	([illegible])	60
PC - 1	PRESSURE REGULATOR		
PI - 2	PRESSURE GAGE - DOWNSTREAM WATER PRESSURE REGULATOR		
PI - 1	PRESSURE GAGE - UPSTREAM MIXER		
SFI - 4	SIGHT FLOW INDICATOR - DETERGENT		[illegible]
SFI - 3	SIGHT FLOW INDICATOR - PHOSPHATE		[illegible]
SFI - 2	SIGHT FLOW INDICATOR - CALCIUM HYPOCHLORITE		[illegible]
SFI - 1	SIGHT FLOW INDICATOR - ORGANIC ACID		[illegible]
FI - 2	DEICING FLUID ROTAMETER		
FI - 1	WATER ROTAMETER		
J - 1	MIXING EDUCTOR		[illegible]
E - 12	SHAFT COUPLING [illegible] TO [illegible] PUMP		[illegible]
E - 11	SHAFT COUPLING BLACKMER PUMP TO SPEED REDUCER		[illegible]
E - 10	SHAFT COUPLING ENGINE TO BLACKMER PUMP		[illegible]
E - 9	DISCHARGE [illegible] HOSE		
E - 8	HOSE CONNECTION - SUCTION		
E - 7	ADJUSTABLE SPRAY NOZZLE		
E - 6	RETRACTABLE HOSE ASSEMBLY - SUCTION W/ HOSE		
E - 5	RETRACTABLE HOSE ASSEMBLY - DISCHARGE		
E - 4	12-VOLT BATTERY		[illegible]
E - 3	GAS ENGINE DRIVE & [illegible] REDUCER		[illegible]
E - 2	BASKET STRAINER - DEICING FLUID		40
E - 1	BASKET STRAINER - WATER		40

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PIPING PLAN - CHEMICAL SOLUTIONS
EXPERIMENTAL DECONTAMINATION APPARATUS

U. S. NAVY
CIVIL ENGINEERING LABORATORY

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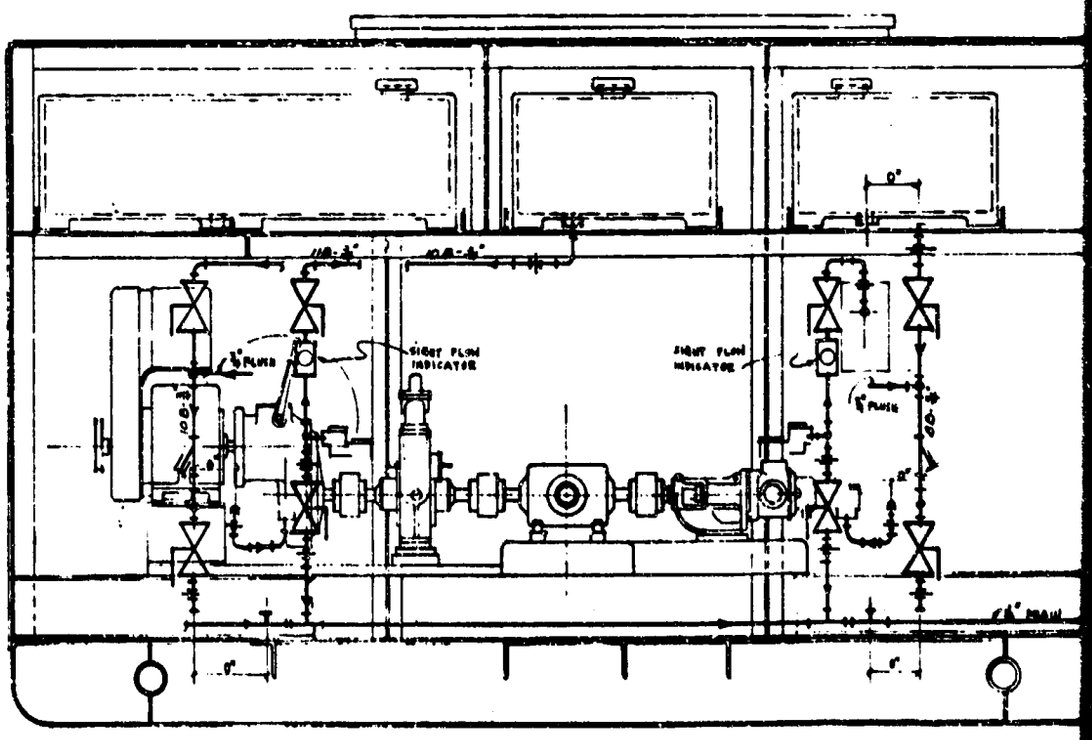
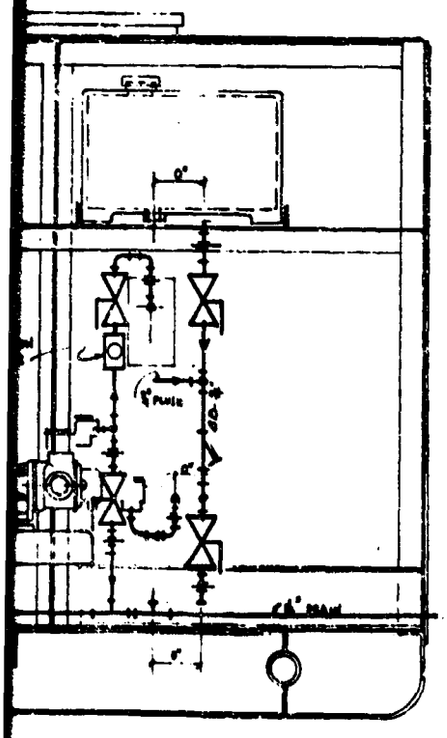

SIGHT FLOW INDICATOR
SIGHT FLOW INDICATOR



MARK	REVISION	BY	CHK	DATE

THE BEN HOLT CO.

TITLE: PIPING ELEVATION - CHEMICAL SOLUTIONS EXPERIMENTAL DECONTAMINATION APPARATUS

CUSTOMER: U.S. NAVY CIVIL ENGINEERING LABORATORY

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Unclas
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) Naval Civil Engineering Laboratory Port Hueneme California 93041	2a. REPORT SECURITY CLASSIFICATION Unclas 2b. GROUP

3 REPORT TITLE

Decontamination Unit for Biological and Chemical Warfare

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

5 AUTHOR(S) (First name, middle initial, last name)

Allan S. Hodgson, Robert S. Chapler

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13 ABSTRACT

A study has been made of a new system developed to update and improve biological and chemical warfare decontamination equipment. An apparatus was required to meter, mix and disperse five specified solutions in water from separate storage tanks with the relative flow rates of the fluids to be maintained with considerable accuracy. The preliminary development of a unit is described. Fabrication of the unit was not pursued because its weight and cost were large enough to suggest that the five solution decontamination mixture must be further evaluated on a laboratory scale to completely justify the necessity of this equipment.

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